Claims

What is claimed is:

1. A micro-stencil comprising:
   a. a membrane with a receptor surface and a print surface, the print surface being patterned with stencil features; and
   b. a flow region through the membrane to allow a print fluid to flow from the receptor surface to the print surface for printing the stencil feature on a medium.

2. The micro-stencil of claim 1, wherein the flow region comprises passages from the receptor surface to the print surface.

3. The micro-stencil of claim 1, further comprising a reservoir for holding and suppling a print fluid.

4. The micro-stencil of claim 3, wherein the reservoir comprises a porous material.

5. The micro-stencil of claim 4, wherein the porous material comprises a material selected from the group consisting metal, glass, quartz, polymer, cellulose, polycarbonate, polytetrafluoroethylene, nylon, polyether sulfone, polypropylene, mixed cellulose and

polyvinylidene fluoride.

6. The micro-stencil of claim 4, wherein the porous material is coupled to the receptor surface of the membrane.

7. The micro-stencil of claim 4, wherein a portion of the porous material is positioned within the flow region.

8. The micro-stencil of claim 1, wherein the stencil features comprise lateral feature dimensions of less than 5.0 microns.

9. The micro-stencil of claim 1, wherein the membrane is formed from a resilient material selected from the group consisting of rubber, silicone, urethane, vinyl, acrylic and nylon.

10. The micro-stencil of claim 1, wherein the membrane is formed from polydimethylsiloxane (PDMS).

11. The micro-stencil of claim 1, wherein a portion of the membrane has a thickness of less than 1.0 micron.

12. The micro-stencil of claim 1, wherein the stencil features comprise an array of stencil features.

13. A method of making a micro-stencil comprising:

a. providing a stamp with a master surface having stencil features; and

b. forming a membrane from the stamp, such that the stencil features are patterned through the membrane and wherein a print fluid is capable of passing through a portion of the stencil features to transfer the print fluid onto a print medium surface.

14. The method of claim 13, wherein the membrane is formed by pressing a liquid material between the master surface and a support surface.

15. The method of claim14, wherein the liquid material is cured while between the master surface and the support surface.

16. The method of claim 14, wherein the membrane is released from the master surface.

17. The method of claim 16, wherein the is membrane is attached to a porous backing.

18. The method of claim 17, wherein the support surface is released from the membrane.

19. The method of claim 13, wherein portions of the support surface are selectively removed to form passages through the support surface.

20. The method of claim 14, wherein the support surface comprises a metal.

21. The method of claim 14, wherein the support surface comprises a porous material.

22. The method of claim 14, wherein the support surface is released from the membrane.

23. The method of claim 22, wherein the membrane is released from the master surface.

24. The method of claim 22, wherein portions of the master surface corresponding to stencil features are selectively removed to from channels through the stamp.

25. The method of claim 22, wherein the master surface is formed from a porous material.

26. The method of claim 13, wherein a portion of the stencil features have lateral dimensions of less than 5.0 microns.

27. The method of claim 13, wherein the membrane is formed from a material selected from the group consisting of rubber, silicone, urethane, vinyl, acrylic and nylon.

28. The method of claim 13, wherein the membrane is formed from polydimethylsiloxane (PDMS).

29. The method of claim 13, wherein the membrane has a thickness of less than 1.0 micron.

30. The method of claim 13, wherein the stencil features comprise an array of stencil features.

31. The method of claim 13, wherein the stamp is formed from a material selected from the group consisting of metal, glass, quartz, silicon and polymer.

32. A method of patterning a micro-stencil comprising:

a. providing a substrate; and

b. forming a print surface patterned with stencil features on the substrate.

33. The method of claim 32, comprising forming a stencil membrane on the substrate, wherein the stencil membrane comprises the stencil features.

34. A method of claim 33, wherein forming the stencil membrane comprises depositing a liquid layer on the substrate and selectively patterning the liquid layer with the stencil features.

35. A method of claim 34, wherein the liquid layer is formed from a material selected from the group consisting of rubber, silicone, urethane, vinyl, acrylic and nylon.

36. The method of claim 34, wherein the stencil membrane is formed from polydimethylsiloxane (PDMS).

37. The method of claim 32, wherein the substrate is formed from a material selected from the group consisting metal, glass, quartz, polymer foam, mixed cellulose, polycarbonate, polytetrafluoroethylene (PTFE), nylon, polyether sulfone (PES), polypropylene, mixed cellulose, polyvinylidene fluoride (PVDF) and polydimethylsiloxane (PDMS).

38. The method of claim 32, wherein the surface is porous with an average pore size between 100 microns to 30 nanometers.

39. The method of claim 33, wherein the liquid layer is cured to form a solid layer prior to selectively patterning the liquid layer with the stencil features.

40. The method of claim 33, wherein forming a stencil membrane on the substrate comprises forming a mask and etching through the mask to form the stencil features.

41. The method of claim 39, wherein the solid layer is patterned to form the stencil features using a method selected from the group consisting of laser ablation, ion beam treatment, electron beam treatment and reactive ion etch.

42. The method of claim 32, wherein a portion of the stencil features have lateral dimensions of less than 5.0 microns.

43. The method of claim 33, wherein a portion of the stencil membrane has a thickness of less than 1.0 microns.

44. The method of claim 33, wherein forming the stencil membrane comprises depositing a liquid material on the substrate to form the stencil features.

45. The method of claim 32, comprising selectively patterning the substrate to form a relief surface defining the stencil features.

46. The method of claim 45, comprising forming the stencil membrane, wherein forming the

stencil membrane comprises depositing liquid polymeric layer on the relief surface, curing the liquid polymer layer and removing the cured polymer layer from the substrate surface.

47. The method of claim 45, comprising forming the stencil membrane, wherein forming the stencil membrane comprises selectively depositing a polymer material on the relief surface of the substrate.

48. The method of claim 33, wherein the stencil membrane is released from the substrate.

49. The method of claim 33, wherein the stencil features comprise an array of stencil features.

50. The method of claim 33, comprising rendering the substrate porous.

51. The method of claim 50, wherein rendering the substrate porous comprises exposing the substrate to a high energy radiation source.

52. The method of claim 50, wherein rendering the substrate porous comprise exposing the substrate to a chemical etchant.

53. A system for printing micro-patterns, the system comprising:

a. a micro-stencil with stencil features;

b. a print fluid supply coupled to the micro-stencil for providing a print fluid through the micro-stencil; and

c. a mechanism for coupling a print surface to the micro-stencil for direct transfer of the print fluid in a pattern of the stencil features onto a print medium.

54. The system of claim 53, wherein the micro-stencil comprises a membrane with portions of the stencil features passing through the membrane.

55. The system of claim 53, wherein the print fluid supply comprises a reservoir.

56. The system of claim 55, wherein the reservoir comprises a porous material coupled to the micro-stencil.

57. The system of claim 53, further comprising a pressure regulator to controllably regulate a pressure difference between the print medium and the print fluid.

58. The system of claim 53, further comprising means to move the print medium and the micro-stencil relative to each other.

59. The system of claim 53, further comprising means to align the print medium with the micro-stencil.

60. The system of claim 53, wherein a portion of the micro-stencil comprises stencil features having lateral dimensions of less than 5.0 microns.

61. The system of claim 54, wherein the membrane has a thickness of less than 1.0 micron.

62. The system of claim 53, wherein the mechanism for coupling the print medium to the micro-stencil comprises a press structure.

63. The system of claim 53, wherein the mechanism for coupling the print medium to the micro-stencil comprises a drum structure.

64. The system of claim 54, wherein the membrane is an elastic membrane and wherein the mechanism for coupling the print medium to the micro-stencil comprises a pressurizing means, whereby the pressurizing means deforms the elastic membrane towards the print medium.

65. A method for building print structures comprising:

a. placing a first micro-stencil comprising a first stencil membrane with a first set of stencil features near a substrate surface; and

b. passing a first print fluid through the first stencil membrane to transfer a first print layer onto the substrate surface.

66. The method of claim 65, wherein the first print fluid is passed from a receptor surface of the stencil membrane to a print surface of the stencil membrane.

67. The method of claim 65, further comprising curing the first print layer.

68. The method of claim 67, wherein the first print layer is cured by a radiation source.

69. The method of claim 68, wherein the first print layer is cured while the first micro-stencil is near the substrate, whereby curing gases escape from the first print layer and pass through the first stencil membrane.

70. The method of claim 69, wherein a pressure differential is controlled across the first stencil membrane such that the pressure at the receptor surface of the first stencil membrane is lower than the pressure at the print surface of the first stencil membrane,

while curing the first print layer.

71. The method of claim 65, wherein a pressure differential is controlled across the stencil membrane such that the pressure at the print surface of the first stencil membrane is less than the pressure at the receptor surface of the first stencil membrane while passing the first print fluid through the first stencil membrane.

72. The method of claim 65, further comprising:

a. placing a second micro-stencil comprising a second stencil membrane with a second set of stencil features near the substrate surface; and

b. passing a second print fluid through the second stencil membrane to transfer a second print layer onto the substrate surface.

73. The method of claim 72, wherein a portion of the first print layer and the second print layer overlap.

74. The method of claim 72, further comprising curing the second print layer.

75. The method of claim 72, further comprising aligning the first micro-stencil with the substrate surface prior to passing the first print fluid through the first micro-stencil and

aligning the second micro-stencil with the substrate surface prior to passing the second print fluid through the second micro-stencil.

76. The method of claim 75, wherein aligning the first micro-stencil and the second micro-stencil with the substrate surface comprises aligning marks on the first micro-stencil and the second micro-stencil with complimentary marks on the substrate surface.

77. The method of claim 65, wherein the first print fluid is selected from the group consisting of a gas, a liquid and a liquid suspension.

78. The method of claim 65, wherein the first print fluid comprises nano-particles.

79. The method of claim 78, wherein the nano-particles comprise at least one material selected form the group consisting of metal, semi-conductor and insulator.

80. The method of claim 72, wherein the second print fluid is selected from the group consisting of a gas, liquid and liquid suspension.

81. The method of claim 72, wherein the second print fluid comprises nano-particles.

82. The method of claim 81, wherein the nano-particles comprise at least one material selected from the group consisting of metal, semi-conductor and insulator.

83. A method for building a multi-layer print structure comprising:

a. placing a first micro-stencil near a substrate surface;

b. passing a first print fluid through the micro-stencil to transfer a first set stencil features onto the substrate surface and forming a first print layer;

c. placing a second micro-stencil near the first print surface; and

d. passing a second print fluid through the second micro-stencil to transfer a second set of stencil features onto the substrate surface and forming a second print surface.

84. The method of claim 83, wherein a portion of the first set of stencil features and the second set of stencil features overlap.

85. The method of claim 84, wherein the overlapping portions of the first set of stencil features and the second set of stencil features form an array.

86. The method of claim 83, wherein a portion of the stencil features of the first micro-stencil and a portion of the second micro-stencil comprise lateral dimensions of less than 5.0

microns.

87. The method of claim 83, wherein first micro-stencil and the second micro-stencil comprise a resilient polymeric membrane.

88. The method of claim 83, wherein at least one of the first and the second print fluids comprise an amino acid moiety.